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09/834,308	04/11/2001	Saleem H. Zaidi	S-041,101	3035

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Samuel M. Freund
11 Timber Ridge Road
Los Alamos, NM 87544

EXAMINER	
MUTSCHLER, BRIAN L	
ART UNIT	**PAPER NUMBER**
1753	7

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Please find below and/or attached an Office communication concerning this application or proceeding.

Office Action Summary	Application No. 09/834,308	Applicant(s) ZAIDI, SALEEM H.
	Examiner Brian L. Mutschler	Art Unit 1753

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If the period for reply specified above is less than thirty (30) days, a reply within the statutory minimum of thirty (30) days will be considered timely.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133).
- Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

1)☒ Responsive to communication(s) filed on *29 July 2002* .

2a)☒ This action is **FINAL**. 2b)☐ This action is non-final.

3)☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

4)☒ Claim(s) *1-24* is/are pending in the application.

4a) Of the above claim(s) _____ is/are withdrawn from consideration.

5)☐ Claim(s) _____ is/are allowed.

6)☒ Claim(s) *1-24* is/are rejected.

7)☐ Claim(s) _____ is/are objected to.

8)☐ Claim(s) _____ are subject to restriction and/or election requirement.

Application Papers

9)☐ The specification is objected to by the Examiner.

10)☐ The drawing(s) filed on _____ is/are: a)☐ accepted or b)☐ objected to by the Examiner.

Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).

11)☐ The proposed drawing correction filed on _____ is: a)☐ approved b)☐ disapproved by the Examiner.

If approved, corrected drawings are required in reply to this Office action.

12)☐ The oath or declaration is objected to by the Examiner.

Priority under 35 U.S.C. §§ 119 and 120

13)☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

a)☐ All b)☐ Some * c)☐ None of:

1.☐ Certified copies of the priority documents have been received.

2.☐ Certified copies of the priority documents have been received in Application No. _____ .

3.☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

* See the attached detailed Office action for a list of the certified copies not received.

14)☐ Acknowledgment is made of a claim for domestic priority under 35 U.S.C. § 119(e) (to a provisional application).

a) ☐ The translation of the foreign language provisional application has been received.

15)☐ Acknowledgment is made of a claim for domestic priority under 35 U.S.C. §§ 120 and/or 121.

Attachment(s)

1) ☐ Notice of References Cited (PTO-892)
2) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)
3) ☐ Information Disclosure Statement(s) (PTO-1449) Paper No(s) _____ .
4) ☐ Interview Summary (PTO-413) Paper No(s). _____ .
5) ☐ Notice of Informal Patent Application (PTO-152)
6) ☐ Other: .

DETAILED ACTION

Comments

1. The objection to the abstract has been overcome by Applicant's amendment.

2. The objection to minor informalities in claims 7, 17 and 18 has been overcome by Applicant's amendment.

3. The rejection of claims 1-24 under 35 U.S.C. 112, second paragraph, has been overcome by Applicant's amendment.

Claim Rejections - 35 USC § 103

4. The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

> (a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negatived by the manner in which the invention was made.

5. Claims 1-3, 6, 8-10, 12 and 13 are rejected under 35 U.S.C. 103(a) as being unpatentable over Zaidi et al. ("Si Texturing with Sub-Wavelength Structures") in view of Braun (U.S. Pat. No. 5,035,770).

Zaidi et al. disclose a method for increasing light absorption of solar cells by fabricating a diffraction grating on the light-incident surface of a silicon substrate (see introduction; fig. 2).

Regarding claims 6 and 8, Zaidi et al. disclose that both conventional wet and reactive ion etching have been used to form a wide range of nanoscale 1-D and 2-D structures on silicon substrates (see abstract).

Regarding claim 9, Zaidi et al. disclose a grating having rectangular profile gratings.

Regarding claim 12, Zaidi et al. disclose the method of coupling the grating to match the solar spectrum of the solar cell (pp. 172).

The method of Zaidi et al. differs from the instant invention because the instant invention requires the following:

a. The grating to be formed on a photo-responsive device comprising a solar cell or photodetector, as recited in claims 1 and 2;

b. The grating comprises a triangular grating, as recited in claim 10; and

c. The step of anti-reflection coating the grating surface, as recited in claim 13.

Regarding claims 1 and 2, Braun teaches a method for forming a grating on a photodetector "to provide low reflectivity surfaces" (col. 1, line 15).

It would have been obvious to one having ordinary skill in the art at the time the invention was made to have modified the method of Zaidi et al. to use a photodetector as disclosed by Braun because increasing the light absorption of a photodetector would improve the efficiency and performance of the photodetector.

Regarding claim 10, Braun teaches the formation of triangular-profiled gratings because "gratings exhibit good antireflective properties and very low diffraction efficiency in backward diffracted orders" (col. 2, line 47).

It would have been obvious to one having ordinary skill in the art at the time the invention was made to have modified the method of Zaidi et al. to create a grating having the triangular-profiled gratings disclosed by Braun because the triangular gratings "exhibit good antireflective properties and very low diffracting efficiencies in backward diffracted orders", as taught by Braun (col. 2, line 47).

Regarding claim 13, Braun also teaches a method of forming an anti-reflective coating on the photodetector, which "effectively lowers the ORL [optical return loss]" (col. 8, line 23).

It would have been obvious to one having ordinary skill in the art at the time the invention was made to have modified the method of Zaidi et al. to form an anti-reflective coating on the grating surface, as taught by Braun, because forming an anti-reflective coating on the grating surface "effectively lowers the ORL [optical return loss]" (col. 8, line 23).

6. Claims 4 and 11 are rejected under 35 U.S.C. 103(a) as being unpatentable over Zaidi et al. ("Si Texturing with Sub-Wavelength Structures") in view of Braun (U.S. Pat. No. 5,035,770), as applied to claims 1-3, 6, 8-10, 12 and 13 above, and further in view of Czubatyj et al. (U.S. Pat. No. 4,419,533).

Zaidi et al. in view of Braun describes a method for creating a grating on a photo-responsive device having the limitations of claims 1-3, 6, 8-10, 12 and 13, as explained above in paragraph 6. However, Zaidi et al. and Braun do not disclose a method of

forming a grating on the surface opposite the light-incident surface, as recited in the limitations of claim 4, or the formation of a blazed grating, as recited in the limitations of claim 11.

Regarding claim 4, Czubatyj et al. disclose a method for producing a diffraction grating on a surface opposite the light-incident surface of the solar cell to "be optimized for reflecting light of predetermined wavelengths and...for selecting the order and reflectance order magnitudes as desired to achieve internal reflection at desired material interfaces" (col. 6, lines 15-22).

It would have been obvious to one having ordinary skill in the art at the time the invention was made to have modified the method described by Zaidi et al. and Braun to form a grating on the surface opposite the light-incident surface as taught by Czubatyj et al. because forming a grating on the surface opposite the light-incident surface could be used "for selecting the order and reflectance order magnitudes...to achieve internal reflection at desired material interfaces" (col. 6, lines 15-22).

Regarding claim 11, Czubatyj et al. teach that blazed gratings are preferred because "the zero order reflections...are minimized" (col. 14, line 51).

It would have been obvious to one having ordinary skill in the art at the time the invention was made to have modified the method described by Zaidi et al. and Braun to form the gratings as blazed grating as taught by Czubatyj et al. because in blazed gratings "the zero order reflections...are minimized" (col. 14, line 51).

7. Claim 5 is rejected under 35 U.S.C. 103(a) as being unpatentable over Zaidi et al. ("Si Texturing with Sub-Wavelength Structures") in view of Braun (U.S. Pat. No. 5,035,770), as applied to claims 1-3, 6, 8-10, 12 and 13 above, and further in view of Solomon (U.S. Pat. No. 4,315,097).

Zaidi et al. in view of Braun describes a method for creating a grating on a photo-responsive device having the limitations of claims 1-3, 6, 8-10, 12 and 13, as explained above in paragraph 6. However, Zaidi et al. and Braun do not disclose a thickness of less than 100 μm, as recited in the limitations of claim 5.

Solomon teaches that "thickness ranges of approximately 50 to approximately 100 microns" for silicon substrates "tends to be most efficient" (col. 4, line 17).

It would have been obvious to one having ordinary skill in the art at the time the invention was made to have modified the method described by Zaidi et al. and Braun to manufacture the photo-responsive device having a thickness of less than 100 microns as disclosed by Solomon because Solomon teaches that thicknesses of approximately 50-100 microns "tend to be most efficient" (col. 4, line 17).

8. Claim 7 is rejected under 35 U.S.C. 103(a) as being unpatentable over Zaidi et al. ("Si Texturing with Sub-Wavelength Structures") in view of Braun (U.S. Pat. No. 5,035,770), as applied to claims 1-3, 6, 8-10, 12 and 13 above, and further in view of Sakaguchi et al. (U.S. Pat. No. 5,492,859) and in view of Ruby et al. (U.S. Pat. No. 6,091,021).

Zaidi et al. in view of Braun describes a method for creating a grating on a photo-responsive device having the limitations of claims 1-3, 6, 8-10, 12 and 13, as explained above in paragraph 6. However, Zaidi et al. and Braun do not disclose a step of using selective KOH to remove surface damage.

In '021, Ruby et al. teaches a second etching step for removing surface damage (col. 5, line 60).

Sakaguchi et al. disclose a selective etching step using KOH (col. 15, line 9).

It would have been obvious to one having ordinary skill in the art at the time the invention was made to have modified the method described by Zaidi et al. and Braun to use a selective etching step using KOH to remove surface damage as taught by Ruby et al. and Sakaguchi et al. because KOH will rapidly and selectively etch the surface.

9. Claim 14 is rejected under 35 U.S.C. 103(a) as being unpatentable over Zaidi et al. ("Si Texturing with Sub-Wavelength Structures") in view of Braun (U.S. Pat. No. 5,035,770), as applied to claims 1-3, 6, 8-10, 12 and 13 above, and further in view of Ruby et al. (U.S. Pat. No. 5,792,280).

Zaidi et al. in view of Braun describes a method for creating a grating on a photo-responsive device having the limitations of claims 1-3, 6, 8-10, 12 and 13, as explained above in paragraph 6. However, Zaidi et al. and Braun do not disclose a step for forming a junction in the solar cell using ion implantation.

In US '280, Ruby et al. disclose a method for forming a junction in a solar cell using ion implantation (col. 4, line 24).

It would have been obvious to one having ordinary skill in the art at the time the invention was made to have modified the method described by Zaidi et al. and Braun to form a junction in the solar cell as taught by Ruby et al. in US '280 because forming a junction using ion implantation would provide a cost-efficient method for forming a solar cell junction in the photo-responsive device.

10. Claims 15, 16 and 19 are rejected under 35 U.S.C. 103(a) as being unpatentable over Ruby et al. (U.S. Pat. No. 6,091,021) in view of Zaidi et al. ("Si Texturing with Sub-Wavelength Structures") and in view of admissions made in the disclosure.

In US '021, Ruby et al. disclose a method for forming a solar cell with a random-textured surface to increase light absorption (col. 1, line 50). Ruby et al. also discloses a method for cleaning the surface of the substrate using a second etching process (col. 5, line 58).

Regarding claim 16, Ruby et al. disclose using reactive ion etching to form the texture on the surface of the solar cell (col. 5, line 16).

The method of Ruby et al. differs from the instant invention because the instant invention requires the following:

a. Forming a grating on the light-incident surface of the solar cell, as recited in claim 15;

b. Forming an n-type junction using gas source doping, as recited in claim 15;

c. Forming n- and p-electrical contacts, as recited in claim 15; and

d. The step of forming the grating comprising wet chemical etching, as recited in claim 19.

Regarding claim 15, Zaidi et al. disclose a method for increasing light absorption of solar cells by fabricating a diffraction grating on the light-incident surface of a silicon substrate (see introduction; fig. 2).

It would have been obvious to one having ordinary skill in the art at the time the invention was made to have modified the method of Ruby et al. to form a grating on the surface of the solar cell as taught by Zaidi et al. because Zaidi et al. teach that "for identically etched structures, uniform structures showed an order of magnitude smaller reflectance than random structures" (see abstract).

Regarding claim 15, on page 14, lines 1-4, of the instant application, the formation of an n-type junction using gas source doping and the formation of n- and p-electrical contacts were disclosed as prior art.

It would have been obvious to one having ordinary skill in the art at the time the invention was made to have modified the method of Ruby et al. to form an n-type junction using gas source doping and to form n- an p-electrical contacts on the solar cell because it is well-known in the art, as disclosed in the instant application.

Regarding claim 19, Zaidi et al. teach that using wet chemical etching and reactive ion etching are both well-known in the art (see abstract).

It would have been obvious to one having ordinary skill in the art at the time the invention was made to have modified the method of Ruby et al. to use the step of forming a grating using wet chemical etching because Zaidi et al. teach that wet chemical etching to form uniform structures is well-known in the art.

11. Claims 17 and 18 are rejected under 35 U.S.C. 103(a) as being unpatentable over Ruby et al. (U.S. Pat. No. 6,091,021) in view of Zaidi et al. ("Si Texturing with Sub-Wavelength Structures") and in view of admissions made in the disclosure, as applied to claims 15, 16 and 19 above, and further in view of Sakaguchi et al. (U.S. Pat. No. 5,492,859).

Ruby et al. in view of Zaidi et al. and in view of admission made in the instant application describe a method having the limitations recited in claims 15, 16 and 19 of the instant invention, as explained above in paragraph 11. However, Ruby et al. and Zaidi et al. do not disclose the method of removing surface damage using wet-chemical etching comprising the step of exposing the surface to KOH and nitric acid solutions.

Sakaguchi et al. teach the use of KOH and nitric acid solutions to perform selective etchings (col. 15, line 6).

It would have been obvious to one having ordinary skill in the art at the time the invention was made to have modified the method described by Ruby et al., Zaidi et al. and admission of the instant application to use KOH and nitric acid solutions to clean the surface damage of the solar cell because KOH and nitric acid solutions will selectively and rapidly etch the surface.

12. Claims 20-24 are rejected under 35 U.S.C. 103(a) as being unpatentable over Ruby et al. (U.S. Pat. No. 6,091,021), herein referred to as US '021, in view of Zaidi et al. ("Si Texturing with Sub-Wavelength Structures"), in view of Ruby et al. (U.S. Pat. No. 5,792,280), herein referred to as US '280, and in view of admissions made in the disclosure.

In US '021, Ruby et al. disclose a method for forming a solar cell with a random-textured surface to increase light absorption (col. 1, line 50). US '021 also discloses a method for cleaning the surface of the substrate using a second etching process (col. 5, line 58).

Regarding claim 21, US '021 discloses using reactive ion etching to form the texture on the surface of the solar cell (col. 5, line 16).

The method of US '021 differs from the instant invention because the instant invention requires the following:

a. Forming a grating on the light-incident surface of the solar cell, as recited in claim 20;

b. Forming an n-type junction by ion implantation, as recited in claim 20;

c. Annealing the solar cell, as recited in claim 20;

d. Forming n- and p-electrical contacts, as recited in claim 20;

e. The step of forming an n-type junction comprises ion implantation using $^{31}P^{+}$, as recited in claim 22;

f. The step of annealing comprises heating the solar cell in an oxygen atmosphere, as recited in claim 23; and

g. The step of forming a grating comprises wet chemical etching.

Regarding claim 20, Zaidi et al. disclose a method for increasing light absorption of solar cells by fabricating a diffraction grating on the light-incident surface of a silicon substrate (see introduction; fig. 2).

It would have been obvious to one having ordinary skill in the art at the time the invention was made to have modified the method of US '021 to form a grating on the surface of the solar cell as taught by Zaidi et al. because Zaidi et al. teach that "for identically etched structures, uniform structures showed an order of magnitude smaller reflectance than random structures" (see abstract).

Regarding claims 20 and 22, US '280 discloses a method for forming a junction using ion implantation of phosphorous (col. 4, line 24).

It would have been obvious to one having ordinary skill in the art at the time the invention was made to have modified the method of US '021 to form an n-type junction in a solar cell using ion implantation of phosphorous as taught by US '280 because forming a junction using ion implantation of phosphorous would provide a cost-efficient method for forming a solar cell junction in the photo-responsive device.

Regarding claims 20 and 23, US '280 also teach a method of annealing the solar cell by heating the solar cell in an oxygen atmosphere (claim 11).

It also would have been obvious to one having ordinary skill in the art at the time the invention was made to have modified the method of US '021 to anneal the solar cell in an oxygen atmosphere as taught by US '280 because annealing the solar cell in an oxygen atmosphere can form an anti-reflecting and passivating oxide layer on the solar cell (claim 11).

Regarding claim 20, on page 14, lines 1-4, of the instant application, the formation of n- and p-electrical contacts was disclosed as prior art.

It would have been obvious to one having ordinary skill in the art at the time the invention was made to have modified the method of US '021 to form n- an p-electrical contacts on the solar cell because it is well-known in the art, as disclosed in the instant application.

Regarding claim 24, Zaidi et al. disclose that both conventional wet and reactive ion etching have been used to form a wide range of nanoscale 1-D and 2-D structures on silicon substrates (see abstract).

It would have been obvious to one having ordinary skill in the art at the time the invention was made to have modified the method of US '021 to use a step to form the grating comprising wet chemical etching because Zaidi et al. teach that both wet chemical etching and reactive ion etching are well-known in the art (see abstract).

Response to Argum nts

13. Applicant's arguments filed July 29, 2002 have been fully considered but they are not persuasive.

14. Applicant has argued that "almost no energy is coupled into obliquely propagating diffraction orders" for one embodiment of Zaidi et al. (see bottom of page 8 of Applicant's response). Diffraction gratings, such as those disclosed by Zaidi et al., are used to produce spectra by diffraction. The results of the gratings are dependent on the wavelength of the radiation incident on the grating. As noted by the Applicant, the particular embodiment used in the calculation couples "almost no energy into obliquely propagating diffracting orders," which corresponds to the orders greater than zero order. However, at least a portion of the radiation is diffracted into the higher diffraction orders, as claimed in the instant invention. Furthermore, the instant claims recite the limitation, "a majority of the incident light entering said photo responsive device propagates obliquely to the surface upon which the light is incident" (claim 1). In figures 7 and 8 of Zaidi et al., the surface has angled sides, which would transmit the entering light obliquely to the surface, assuming normal incidence.

15. Applicant has argued that the reference of Zaidi et al. teaches away from the instant invention because the device of Zaidi et al. "behaves as an anti-reflection coating, while being substantially unsuitable for the diffraction coupling which is the subject of the claimed invention", and that "the gratings of the present invention may not completely reduce surface reflection from a substrate" (see page 9 of Applicant's response). This argument is not persuasive because Zaidi et al. teach the use of

gratings to decrease the amount of reflected light from the surface, which is the same as increasing the amount of light absorbed by the device, as claimed in the instant invention. Furthermore, in figure 3, Zaidi et al. show that the gratings do not completely reduce surface reflections, although they significantly increase the amount of light absorbed.

16. The properties of diffraction gratings are designed for the intended use of the diffraction gratings. Each of the diffraction gratings disclosed by Zaidi et al. would produce a different result because of the geometry, period, depth, etc., of the grating, as well as the wavelength of the incident radiation. Zaidi et al. seek to achieve increased absorption of incident light through the use of diffraction gratings, which is the same objective as that of the instant invention. Therefore, the teachings of Zaidi et al. are considered relevant and do not teach away from claims of the instant invention.

Conclusion

17. **THIS ACTION IS MADE FINAL.** Applicant is reminded of the extension of time policy as set forth in 37 CFR 1.136(a).

A shortened statutory period for reply to this final action is set to expire THREE MONTHS from the mailing date of this action. In the event a first reply is filed within TWO MONTHS of the mailing date of this final action and the advisory action is not mailed until after the end of the THREE-MONTH shortened statutory period, then the shortened statutory period will expire on the date the advisory action is mailed, and any extension fee pursuant to 37 CFR 1.136(a) will be calculated from the mailing date of

the advisory action. In no event, however, will the statutory period for reply expire later than SIX MONTHS from the mailing date of this final action.

Any inquiry concerning this communication or earlier communications from the examiner should be directed to Brian L. Mutschler whose telephone number is (703) 305-0180. The examiner can normally be reached on Monday-Friday from 8:00am to 4:30pm.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Nam Nguyen can be reached on (703) 308-3322. The fax phone numbers for the organization where this application or proceeding is assigned are (703) 872-9310 for regular communications and (703) 872-9311 for After Final communications.

Any inquiry of a general nature or relating to the status of this application or proceeding should be directed to the receptionist whose telephone number is (703) 308-0661.

NAM NGUYEN
SUPERVISORY PATENT EXAMINER
TECHNOLOGY CENTER 1700

blm
August 26, 2002